REMARKS

INTRODUCTION

Claims 1-7 were previously pending.

Claims 1-7 stand rejected.

Claims 1, 2, and 4-7 are amended herein.

Claims 8-13 have been added herein.

Claims 1-13 are now pending and under consideration.

No new matter is being presented, and approval and entry are respectfully requested.

OBJECTION TO DRAWINGS

The drawings have been amended to illustrate coordinate systems and optical axes.

Figures 5 and 6 have been labeled "Prior Art."

The requirement to label Figures 11-13 as "Prior Art" is respectfully traversed. Figures 11-13 show features discussed in the Detailed Description of the present invention. The present specification does not characterize these figures as prior art. The Examiner is respectfully requested to cite a prior art reference indicating that the subject matter in Figures 11-13 is prior art. It is also submitted Figures 11-13 are not prior art because they show techniques for generating teaching model data used later for pattern matching to determine a position or direction of a model. As discussed below, this is not found in the prior art.

Withdrawal of the objection is respectfully requested.

PRESENT INVENTION

In one aspect, the present invention relates to using a robot to capture images of a reference, object, according to different directions, orientations, positions, arrangements, etc. Each image is associated with respective information indicating the arrangement etc. when the image was taken. The image data or images can be stored and then used to automatically

determine orientations of subjects or objects with shapes similar or identical to the reference object.

As recited in new claim 12, an aspect of the present invention may be thought of as: robotically taking images of a subject with different subject-camera arrangements and associating with each image information indicating its subject-camera arrangement; then taking a current image of a workpiece shaped like the subject; and then determining a current workpiece-camera arrangement by matching one of the images with the with current image, and using both the known arrangement of the camera and the predetermined subject-camera arrangement of the matched image to determine the arrangement of the workpiece relative to the camera (see new claim 12).

PRIOR ART

Suzuki discusses a system for analyzing images of an object viewed from various angles to determine the construction of the object. For example, Suzuki determines the positions and directions of edges and components of the object. This de-construction in Suzuki is then used to determine a program of robot instructions for assembling the object.

As discussed below with reference to the claims, Suzuki does not discuss determining a current position/direction of an object using pattern matching and the predetermined image and associated position/direction information.

REJECTIONS UNDER 35 USC § 112, SECOND PARAGRAPH

In the Office Action, at pages 3-4, claims 1-3 were rejected under 35 U.S.C. § 112, second paragraph, for the reasons set forth therein. The claims have been amended. Withdrawal of the rejection is respectfully requested.

OBJECTED DRAWINGS

The drawings have been corrected as suggested, with the exception of Figures 11-13. It is respectfully submitted that no prior art teaches the content of Figures 11-13. Furthermore,

such content is not prior art because of its use in conjunction with patentably distinct features discussed above. For example, lines 10 and 11 on page 11 of the present specification mentions "[t]he two-dimensional array data produced as discussed above [with reference to Figs. 11-13] may be used as the image data to generate teaching models".

REJECTIONS UNDER 35 USC §§ 102 AND 103

In the Office Action, at pages 4 and 5, claims 1, 3 and 4 were rejected under 35 U.S.C. § 102 as anticipated by Suzuki (USPN 4,835,450). In the Office Action, at pages 5-7, claims 2, 5 and 6 were rejected under 35 U.S.C. § 103 as being unpatentable over Suzuki in view of Werth et al. (USPN 4,504,970). Claim 7 was rejected in further view of Ninomiya (USPN 4,611,292). These rejections are traversed and reconsideration is requested.

Claim 1, for example, recites "a current three-dimensional position and/or posture of [said] the subject object is recognized by carrying out pattern matching processing of an image of the subject based on [of] a plurality of pre-determined teaching models of the reference object". In contrast, Suzuki uses captured images of an object for de-constructing the object.

As shown in Figure 1 of Suzuki, Suzuki uses captured images to pre-detect the construction of an object. Information reflecting the detected construction is then used for task and motion planning, which then controls the motion of a robot when constructing a like object ("Accordingly, when a product is constructed in the same manner as described in FIGS. 8A to 8D, the task sequence is set on the basis of a predetermined constructing rule"). Suzuki mentions the robot using a camera during construction, but it does not mention any detail of how that camera is used. The only discussion of using the camera during construction is: "an operation of moving the part is performed by correcting an operation of robot 3 in accordance with feedback signals from the pair of CCD cameras 11a and 11b, and pressure sensors 8 and 9". Suzuki's CCD camera could be used, for example, in a simple manner such as identifying the presence or location of a part.

Suzuki's moving robot does not use a camera or image pickup device to capture another image used for pattern matching. Rather the robot moves according to the detected construction; the motion is pre-planned. Suzuki's claim 1 further supports this understanding. Suzuki's claim 1 discusses "measuring a 3-dimensional form ... by imaging ... from a plurality of

directions", "detecting the construction from the measured 3-dimensional form", and generating movement task sequences based thereon. Suzuki does not discuss using the images captured from different directions for any purpose other than detecting the construction of the object.

In sum, Suzuki does not discuss using an image of a subject and pattern matching on previously captured images to determine a position or orientation of the object after such images have been captured. The other references were not cited for, and do not add or suggest the feature discussed above.

The difference in how claim 1, for example, uses pre-captured images, and how Suzuki uses images, is further apparent in claim 1's recitation of a "reference object" and a "subject object". The "reference object" is imaged in advance. Later, a direction or position of a "subject object" is determined using pattern matching with the images of the "reference object". Suzuki does not discuss this feature, but rather discusses capturing images of only one object, and processing the images at one time to de-construct the object. Later use of a camera is only generally mentioned.

Various of the claims have been amended to remove "means" language, and have not been narrowed by such amendments.

Withdrawal of the rejection is respectfully requested.

DEPENDENT CLAIMS

The dependent claims are deemed patentable due at least to their dependence from allowable independent claims. These claims are also patentable due to their recitation of independently distinguishing features. For example, claim 4 recites "said teaching model is composed of data obtained by performing image processing on the image data of the reference object". This feature is not taught or suggested by the prior art. Withdrawal of the rejection of the dependent claims is respectfully requested.

NEW CLAIMS

New claims 8-13 have been added to clarify an aspect of the present invention in which a current image of a subject is pattern-matched against the previous to determine a current

arrangement, orientation, etc. of the subject with respect to the current arrangement etc. of the image capture device.

CONCLUSION

There being no further outstanding objections or rejections, it is submitted that the application is in condition for allowance. An early action to that effect is courteously solicited.

Finally, if there are any formal matters remaining after this response, the Examiner is requested to telephone the undersigned to attend to these matters.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: 31 March 2003

By: James Strom
James T. Strom
Registration No. 48,702

700 Eleventh Street, NW, Suite 500
Washington, D.C. 20001
(202) 434-1500

CERTIFICATE UNDER 37 CFR 1.8(a)
I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231
on March 31, 2003
STAAS & HALSEY
By: Marie Anderson
Date: March 31, 2003

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Please AMEND the paragraph that begins at page 8, line 2 with the following:

An image produced by the image pickup device 20 is stored in the image memory 26. The image processor 33 conducts processing of the image stored in the image memory according to a command from the processor 31 to recognize the object. The image processing device 30 is similar in configuration and function to an image processing device in the prior art. However, according to the present invention, the image processing device 30 is characterized in that teaching models (described later) are stored in the non-volatile memory 37, and pattern matching is carried out by using the stored teaching models, for the image data of the pile of workpieces photographed by the image pickup device 20 to obtain three-dimensional position and posture of the workpiece.

IN THE CLAIMS:

Please AMEND the claims in accordance with the following:

1. (ONCE AMENDED) A teaching model generating device for image processing, in which [an] a subject object [or an article having] has the same or substantially similar shape as that of [the object is selected as] a reference object, and], the device comprising:

an image processing system with which a current three-dimensional position and/or posture of [said] the subject object is recognized by carrying out pattern matching processing of an image of the subject based on [of] a plurality of pre-determined teaching models of the reference object; and [,which were generated and stored]

an image-capture system, in advance of the recognizing, generating and storing the plurality of teaching models on the basis of [the] respective image data produced by taking [the image] images of said reference object from a plurality of directions, [with the image data including the object,] wherein one of the reference object and [the] an image pickup device [means is fixed in place, while the other] is fixed to a movable part of a robot or is grasped with a hand of the robot, and said robot is operated for positioning to a plurality of different image pickup positions and directions [where direction of the optical axis of said image pickup means with respect to the reference object is different from one another respectively], so that the image

data respectively obtained at each of said different image pickup positions is stored as a teaching model.

2. (ONCE AMENDED) A teaching model generating device for image processing, in which [an] a subject object [or an article having] has the same or substantially similar shape as that of [the object is selected as] a reference object, and], the device comprising:

an image processing system with which a current three-dimensional position and/or posture of [said] the subject object is recognized by carrying out pattern matching processing of an image of the subject based on [of] a plurality of pre-determined teaching models of the reference object; and [,which were generated and stored]

an image-capture system, in advance of the recognizing, generating and storing the plurality of teaching models on the basis of [the] respective image data produced by taking [the image] images of said reference object from a plurality of directions, [with the image data including the object,] wherein the reference object is fixed to a movable part of a first robot or is grasped with a hand of the first robot, and an image pickup means is fixed to a movable part of a second robot or is gasped with a hand of the second robot, and any one of or both of said first and second robots is operated for positioning to a plurality of different relative image pickup positions and directions [where direction of the optical axis of said image pickup means with respect to the reference object is different from one another respectively], so that the image data respectively obtained at each of said different image pickup positions is stored as a teaching model.

3. (AS ONCE AMENDED) A teaching model generating device according to claim 1, wherein said teaching model is a part of the image data of the reference object.

4. (TWICE AMENDED) A teaching model generating device according to claim 1, wherein said teaching model is composed of data obtained by performing [a] image processing on the image data of the reference object.

5. (TWICE AMENDED) A teaching model generating device according to claim 2, wherein said teaching model is generated for every direction in which said image pickup [means] device took the image of said reference object and said teaching model is stored in association with [the] information on the direction.

6. (TWICE AMENDED) A teaching model generating device according to claim 2, wherein said image pickup [means] device is a camera.

7. (TWICE AMENDED) A teaching model generating device according to claim 2, wherein said image pickup means is a three-dimensional visual sensor whose image pickup [means] device measures the distance between the image pickup [means] device and a plurality of points on the object.

8. (NEW) A method for teaching model generation and image processing, comprising:

determining a current three-dimensional position and/or posture of a subject object by carrying out pattern matching processing of an image of the subject based on a plurality of predetermined teaching models of a reference object; and

in advance of the determining, generating and storing the plurality of teaching models on the basis of respective image data produced by taking images of said reference object from a plurality of directions, wherein one of the reference object and an image pickup device is fixed to a movable part of a robot or is grasped with a hand of the robot, and said robot is operated for positioning to a plurality of different image pickup positions and directions, so that the image data respectively obtained at each of said image pickup positions is stored as a teaching model.

9. (NEW) A method of automatic orientation recognition, comprising:

generating and storing a set of images of different relative orientations of a subject, the images having been captured by a plurality of robotic operations corresponding to the different relative orientations of the subject, and associating with each image information indicating its respective relative orientation of the subject;

with a known current orientation of a robot, capturing a current image of a workpiece that has an unknown orientation relative to the robot, where the workpiece has a shape substantially similar to the shape of the subject;

using pattern matching to match one of the stored images with the current image; and

determining the orientation of the workpiece relative to the robot based on the relative orientation information associated with the matched stored image, and also based on the known current orientation of the robot.

10. (NEW) A method according to claim 9, further comprising automatically maneuvering the robot to the workpiece based at least on the determined orientation of the workpiece relative to the robot.

11. (NEW) A method according to claim 9, wherein the generating and storing is performed for a plurality of differently shaped subjects, wherein the current image includes a plurality of differently shaped workpieces, and wherein the pattern matching further comprises identifying the workpiece from among the plurality of differently shaped workpieces using the images and orientation information of the plurality of differently shaped subjects.

12. (NEW) A method of automatic orientation recognition, comprising:

generating and storing a set of images of different relative arrangements of a subject, the images having been captured by a plurality of robotic operations corresponding to the different relative arrangements, and associating with each image information indicating its respective relative arrangement of the subject;

with a known current arrangement of a robot, capturing a current image of a workpiece with an unknown current arrangement relative to the robot, where the workpiece has a shape substantially similar to the shape of the subject;

using pattern matching to match one of the stored images with the current image; and

determining the current arrangement of the workpiece relative to the robot based on the relative arrangement information associated with the matched stored image, and also based on the known current arrangement of the robot.

13. (NEW) A method, comprising:

robotically taking images of a subject with different subject-camera arrangements, and associating with each image information indicating its subject-camera arrangement; then

taking a current image of a workpiece shaped like the subject; and then

determining a current workpiece-camera arrangement by matching one of the images with the with current image, and using predetermined subject-camera arrangement information of the matched image to determine the arrangement of the workpiece relative to the camera.